



THE IMPLEMENTATION OF PROBLEM BASED LEARNING TO IMPROVE STUDENTS' LEARNING ACHIEVEMENTS

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ABSTRACT

The students' learning achievements of the seventh grade students in Semarang is still not optimal so that it is necessary to implement learning model and approach that can solve the problem. Problem Based Learning (PBL) models can be applied to improve student learning achievements. The purpose of this study was to improve the average of students' learning achievements of the seventh grade students on learning PBL model. Two groups were randomly selected for use as a sample, i.e. as an experimental group and a control group for each group as many as 32 students of the seventh grade. Data collection in this research used test method. Both groups were given pretest and posttest with the same instrument. The data obtained were tested using the normalized gain test and the average paired differential test. The results showed that there is an increase in average learning achievements of the seventh grade students on learning PBL model on the subject matter of quadrilaterals. So it can be concluded that the application of PBL learning model can improve student learning achievements.

KEYWORDS: Problem Based Learning, students' learning achievements, quadrilaterals

INTRODUCTION:

Mathematical content is included in the Science and Technology subjects group aimed at developing students' logic and analytical thinking skills (Mulyasa, 2010).¹¹ One of the difficulties of students in learning mathematics is on aspects of understanding the concepts, reasoning and problem solving in rectangular material. The student difficulties can be seen from the still not optimal mathematics learning achievements of the seventh grade students in Semarang, Indonesia, especially in rectangular materials where students tend to memorize formulas looking for perimeter and the area of the quadrilateral. This is reinforced by the data percentage of mastery of two dimensional material which includes a quadrilateral in the national junior high school exam year 2012/2013 Central Java province of 50.12%. This result is still below the percentage of mastery of the two dimensions of the national level of 54.95% (BSNP, 2013).⁵

The low students mathematics learning achievements can be caused by various things such as the learning model applied in the school, the learning media used and the learning motivation of the students. The tendency of learning in the classroom is the dominance of teachers and students are not actively involved in learning. It is like conventional learning in general where teacher-centered learning and students receive only what their teacher teaches. In fact, according to various studies, student-centered learning and involving students actively will make students find their own concepts that impact on improving learning achievements. Such as cooperative learning where students are actively involved in group discussions, which gives a positive impact on learning achievements. The results of Zakaria (2010) study on 44 students with 13 years age range found that cooperative learning had an effect on improving learning achievements and student attitudes toward mathematics.¹⁷

Alabekee (2015) found that cooperative learning models allow learners to receive positive feedback from thinking processes, problem solving and group interaction, thereby resulting in better skills and understanding of educational concepts and in the division of tasks.²

Thus, cooperative learning enables students to achieve optimal mathematics learning achievements compared to individualized learning.

To overcome the problem of less optimal students learning achievements, the need for innovative learning. Innovation in this case could be a learning model. The learning model was intended as a pattern of interaction of students with the teacher in the classroom concerning strategies, approaches, methods and learning techniques applied in the implementation of teaching and learning activities in the classroom (Suherman, 2003).¹⁶

This form of innovation in the form of cooperative learning that encourages students to move groups in finding their own mathematical concepts on quadrilateral topics. One example of cooperative learning is the problem-based learning model (PBL). This is in consistent with the definition of cooperative learning according to Alabekee (2015) i.e. learning by forming small groups so that students work together to achieve common goals.²

In PBL learning, students are organized to form small groups to solve a problem which then discussed the results, so that the PBL is one of cooperative learning. Padmavathy (2013) in his research found that PBL has an effect in learning mathematics and improving students' conceptual understanding, as well as the ability

to use concepts in real life.¹³

PBL is also able to improve the thinking and soft skills of students in meeting the demands of education in the 21st century (Mustaffa, 2016).¹²

Li's research results (2017) to 35 fifth grade students who for one year received PBL learning showed an increased understanding of mathematical concepts and supported the idea that PBLs have a positive effect on long-term retention of knowledge.⁸

In line with Li, Merrit's review literature review (2017) found that PBL is effective in improving students' mathematics and science learning achievements over 3-14 years of age, including knowledge retention, conceptual development and attitudes.¹⁰

Therefore, the application of PBL in mathematics learning provides benefits in order to improve the conceptual understanding, attitude, and storage of knowledge.

In this study, the learning model used is PBL or Problem Based Learning. Characteristic of PBL according to Barrows (1996) is learning occurs in small student groups, teachers are facilitators or guides, problems form the organizing focus and stimulus for learning, new information is acquired through self-directed learning.³

The PBL learning model applied to this experimental group is student-centered learning with the problem as a stimulus for learning. The problem given is a real problem that corresponds to everyday life. The form of problem students will learn is an open-ended problem. Franz (2007) explained that problems in PBL at least derived from the open-ended problem to connect the previously learned knowledge with the goal to be achieved.⁷

The goal to be achieved in this case is to improve student learning achievements, so that students need to be stimulated by providing open-ended problems about rectangular material. Rusmono (2012) added that the problem used to be: relevant to the learning objectives, current and interesting, based on extensive information, formed consistently with other problems, and is included in the human dimension.¹⁴

Based on the above, the purpose of this study was to improve the students' learning achievements of the seventh grade students on learning PBL on the subject matter of quadrilaterals.

MATERIALS AND METHODS:

This type of research was experimental research. Research conducted at one of school in Semarang. The sample was 32 students as an experimental group and 32 students as a control group. The selected sample was from a normally distributed population and its variance was homogeneous. Design research can be seen in the Table 1 below.

**Table 1: Research Design pretest-posttest control group design
Test group Treatment Test**

Group	Test	Treatment	Test
Experiment	P	X	T
Control	P	C	T

Description:

P: Pretest; T: Posttest; X: PBL; and C: Conventional

Student learning achievements included three aspects, namely cognitive, affective and psychomotor aspects. Student learning achievements in this study focused on cognitive aspects. Therefore, the method of data collection is the test method.

The test method used in this research was pretest and posttest. Pretest was done to obtain the data of student learning achievements before being given treatment in the form of PBL learning model. After obtaining learning with PBL model, students were given posttest to get the data of learning achievements value. Implementation of pretest and posttest using the same instrument. The instruments were based on indicators of conceptual comprehension, reasoning and problem solving. The material used was rectangular material. The test instrument consisted of two parts, the first part was in the form of multiple choice questions and the second part took the form of an essay with the type of open-ended question or had a strategy of completion and answer of more than one. Number of items about multiple choice that was eight problems and number of item about essay which was six problems.

Prior to being used as an instrument on pretest and posttest, the instrument was piloted in a pilot class with a working time of 80 minutes. The results of these trials were then analyzed to obtain items that were suitable to be used as test instruments. The analysis was in the form of analysis of validity, level of difficulty, item discrimination, and reliability. The result of the analysis was that there were two items on the multiple choice and one item on the essay that the validity was low ($r_{xy} \leq 0,325$). This led to items of low validity not included in test instruments on pretest and posttest. Based on the reliability analysis, obtained the value of multiple choice test reliability was $r_{11}=0,694$ which were included in the high reliability criteria, as well as the reliability value of the test essay form ie $r_{11}=0,728$ which was also included in the high reliability criteria. Based on the analysis on other valid items, it could be concluded that the item had been feasible and could be used in the test instrument.

After obtaining the item that met the eligibility criteria, the instruments for pretest and posttest were ready for use. Instruments used for pretest and posttest consisted of six items of multiple choice and five item essays. The procedure of pretest and posttest implementation was the same, but different at the time of implementation that was pretest implemented before the students in the experimental group get the learning treatment of PBL model while the posttest were implemented after the students get the learning model of PBL. As for the control group, pretest was applied before the learning with conventional model was applied and posttest was executed after conventional learning was applied. Both during pretest and posttest, the working time of the problem was 80 minutes. Students were not allowed to use calculation tools such as calculators. In the implementation of pretest and posttest, the researcher served as a test supervisor.

To analyze the data obtained, first the results of student answers compared with scoring rubric to obtain data score of each individual score on both pretest and posttest. The individual score of each multiple choice item was one and the score of each essay item was 12 if the student answered correctly. The maximum value students could get if they could answer all questions exactly was 100. After that, the average grade was obtained. To know the increase from pretest to posttest, a normalized gain test was performed. After obtaining the N-gain value, the results were categorized whether included in the category of low, medium or high increase. Student learning achievements data was then analyzed using paired average difference test and normalized gain test. The paired average difference test was conducted to find out whether the result of the students' posttest in the experimental group was significantly different than the pretest result.

RESULTS AND DISCUSSION:

The researchers conducted a normalized gain test to determine the improvement of student learning achievements in the experimental group. Furthermore, researchers categorized the acquisition of N-gain value calculation results into categories of high, low or moderate increase. The researchers also tested the paired average difference to see the significance of differences in pretest and posttest results. Based on the pretest and posttest conducted on the experimental group and control group, the data obtained from the students' learning achievements. The pretest and posttest results in both groups are shown in Table 2 and Table 3.

Based on the Table 2 and Table 3, both experimental and control groups experienced an increase in learning achievements with posttest was greater than the value of pretest. Based on the result of normalized gain test in increasing the average of experimental group learning achievements obtained value $\langle g \rangle = 0,56$. This value was included in the moderate increase criteria. This means that the average

value of students' learning achievements in the experimental group has a moderate increase.

Table 2. Data pretest student learning achievements

Descriptive Statistics	Experimental Group	Control Group
Number of students	32	32
Top Value	59	65
Lowest Value	27	11
Average	38,13	35,25
Variance	54,95	269,61
Standard Deviation	7,41	16,42

Table 3: Data posttest student learning achievements

Descriptive Statistics	Experimental Group	Control Group
Number of students	32	32
Top Value	94	76
Lowest Value	42	32
Average	76,53	53,93
Variance	101,48	111,6
Standard Deviation	10,07	10,56

The significance of the difference of posttest result of the students in the experimental group with the pretest result was done using the difference test of the paired average. Based on the calculation results obtained values $t_{\text{calculation}} = 14,9$. Based on the t table with $n = 32$, $dk = (n-1) = (32-1) = 31$ and $\alpha = 5\%$, earned value $t_{1-\alpha}$ was 1,698. Because $t_{\text{calculation}} \geq t_{(1-\alpha)(31)}$, this means the mean value of the experimental group posttest results differ significantly with the average of pretest results higher than the average pretest result.

This increase is because the applied PBL learning model presents real problems that are able to cultivate students' interest in the material. Real problems tested both in pretest and posttest were non-routine open-ended problem on rectangular material. Through this open-ended problem, students are able to hone their creativity skills in solving problems with diverse solutions. The ability of creative problem solving can be grown through students' habit of solving open-ended problems (Kwon, 2006) so that it has implications for the increase of students' mathematics learning achievements.⁹

Having presented the open-ended real problem problems and read carefully the problem, students were then organized to study in groups. The teacher formed a small group of four students to discuss in solving the problem. Each group discussed a similar issue.

Furthermore, the teacher guided individual and group investigations. In this phase, the students conducted group discussions to solve the given problem and found their own mathematical concepts with the help of the worksheet and the guidance from the teacher who acted as the facilitator. This is in line with the opinion of Rusmono (2012) that in the dimension of conceptual knowledge, learning achievements achieved by students in the form of an understanding of the concepts of subjects studied, as a result of student group work with the help of various learning resources, such as student handbooks and worksheets.¹⁴

The implication is that when students are able to find their own concepts by studying in groups with teacher guidance, students do not need to memorize many formulas of the perimeter or quadrilaterals areas. This is useful because students do not easily forget the mathematical concepts they have learned. Learning through this group work system has a number of advantages. The advantages of students working in groups are that students perform better on standardized tests than with students working individually (Brush, 1997).⁴

When conducting group work, the student asked things they do not know about the problem, and the student was responsible for collecting information to solve the problem and with the reasoning ability finding the mathematical concept. The next phase was students developed and presented the work where students communicate the results of problem solving to others. After that was analyze and evaluate the process of problem solving. Students were responsible for responding to problem solving results. Through the stages in the PBL, students can improve learning achievements that include conceptual understanding, reasoning and problem solving. This is consistent with the results of research Ajai (2013) to four hundred and forty seven senior secondary one that PBL able to improve student learning achievements on algebra materials and not dependent on the gender of students.¹

Another study conducted by Fatade (2013) on 42 students who were taught using PBL and 54 students who were taught using traditional learning methods found a significant mean difference in the achievement of mathematics posttest scores of students taught by using PBL and students taught using methods traditional learning.⁶

Fatade also added that PBL learning can create meaningful math learning.⁶

Figure 1 showed the results of the students' answer on one of the open-ended questions of determining the quadrilateral picture that were known the area was 76cm^2 . This student had a slight problem in the concept of determining the formula of parallelogram area.

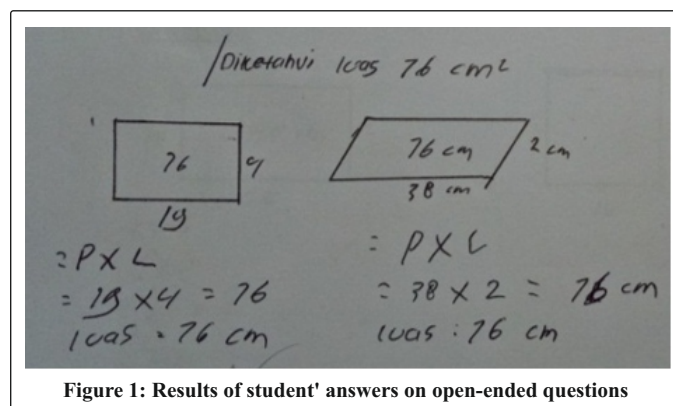


Figure 1: Results of student's answers on open-ended questions

The translation:

Known: the area of quadrilateral is 76cm^2 .

Area of rectangle is

length \times width $= 19 \times 4 = 76\text{ cm}$.

Area of parallelogram is

length \times width $= 38 \times 2 = 76\text{ cm}$.

Based on the student's answer, he had been able to understand the question on the problem by describing two kinds of quadrilateral i.e. rectangular and parallelogram. In the rectangular picture, the student was able to write the formula of rectangular area correctly and the answer was correct, but the student had an error in listing the unit area, he wrote the unit area in the unit length. Whereas in the parallelogram picture, the student was wrong in writing the formula of the area, he wrote the formula of the rectangular area. In this case, students had been able to interpret the question in an open-ended question by answering more than one answer. Errors that occur was on understanding the concept on the determination of the formula of parallelogram area and the writing of the unit area. This problem could be used as a record for further research to the students conceptual understanding about the area of the quadrilateral could be developed.

The improvement of students' learning achievements of the experimental and control groups showed in the Figure 2.

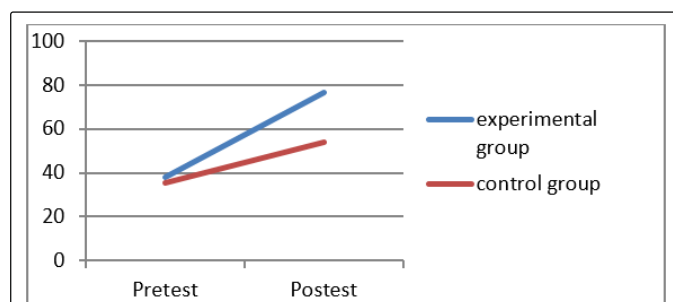


Figure 2: Improvement of students' learning achievements of the experimental and control groups.

In the Figure 2, it can be seen that the increase in experimental group learning achievements was higher than that of the control group learning achievements. This can be seen from the blue line indicating the increase of the pretest score to the experimental group posttest above the red line indicating the increase of the pretest score to the control group posttest. In the experimental groups, learning was student-centered and students were given an open-ended problem that has more than one answer or more than one correct solving problems strategy while in the control group, learning was teacher-centered and problems given to students were routine problems. In addition, the experimental group applied the learning system by forming small groups consisting of four students while in the control group applied individual learning system. Through group learning, each member of the group can help each other in supporting the success of learning (Slavein, 1989) so that it is able to spur students to succeed in learning mathematics and implicate the increase in mathematics learning achievements.¹⁵

CONCLUSIONS:

Based on the results and discussion of the research, it can be concluded that there is an increase in average learning achievements of the seventh grade students on

learning PBL model on the subject matter of quadrilaterals. The improvement of students' learning achievements of the experimental group is higher than the improvement of the control group learning achievements, so it can be concluded that the application of PBL learning model which in student-centered learning can be superior in improving student learning achievements. Providing non-routine open-ended problems with group learning systems in the experimental group also makes students more able to solve problems creatively and among group members can support each other in solving the problem successfully, compared with students in the control group in the learning given routine problems and learning system in individual. So it can be concluded that the application of PBL learning model can improve student learning achievements.

The suggestion that can be given to seventh grade math teacher is that teachers can apply PBL learning model in teaching mathematics to quadrilateral material, because based on the research result, PBL application can improve student learning achievements in rectangular material. Further research on the effectiveness of PBL learning models in improving students' mathematics learning achievements needs to be implemented in larger sample scales and longer durations of time so that the benefits of PBL and the factors that influence student learning achievements can be studied more deeply.

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REFERENCES:

- Ajai, J. T., Imoko, B. I., & O'kwu, E. I. (2013). Comparison of the Learning Effectiveness of Problem-Based Learning (PBL) and Conventional Method of Teaching Algebra. *Journal of Education and Practice*, 4(1), 131-136.
- Alabekee, E. C., Samuel, A., & Osaat, D. S. (2015). Effect of cooperative learning strategy on students learning experience and achievements in mathematics. *International Journal of Education Learning and Development*, 3(4), 67-75.
- Barrows, H. S. (1996). Problem-based learning in medicine and beyond: A brief overview. *New directions for teaching and learning*, 1996(68), 3-12.
- Brush, A. T. (1997). The effects on student achievement and attitudes when using integrated learning systems with cooperative pairs. *Educational Technology Research and Development*, 45(1), 51-64.
- BSNP. (2013). *Laporan hasil ujian nasional SMP/MTS tahun ajaran 2012/2013*. [Online]. Retrieved from <http://www.bsn-p-indonesia.org/id/wp-content/upload/-2013/04/laporan-BSNP-2013.pdf>
- Fatade, A. O., Mogari, D., & Arigbabu, A. A. (2013). Effect of Problem-Based Learning on Senior Secondary School Students' achievements In Further Mathematics. *Acta Didactica Napocensia*, 6(3), 27.
- Franz, D. P., Hopper, P. F., & Kritsonis, W. A. (2007). National Impact: Creating Teacher Leaders Through the Use of Problem-Based Learning. *Online Submission*, 20(3), 1-9.
- Li, H. C., & Tsai, T. L. (2017). The implementation of problem-based learning in a Taiwanese primary mathematics classroom: lessons learned from the students' side of the story. *Educational Studies*, 43(3), 354-369.
- Kwon, O. N., Park, J. H., & Park, J. S. (2006). Cultivating divergent thinking in mathematics through an open-ended approach. *Asia Pacific Education Review*, 7(1), 51-61.
- Merritt, J., Lee, M. Y., Rillero, P., & Kinach, B. M. (2017). Problem-Based Learning in K-8 Mathematics and Science Education: A Literature Review. *Interdisciplinary Journal of Problem-Based Learning*, 11(2), 3.
- Mulyasa. (2010). *Kurikulum Tingkat Satuan Pendidikan*. Bandung: PT Remaja Rosdakarya.
- Mustaffa, N., Ismail, Z., Tasir, Z., & Said, M. N. H. M. (2016). The Impacts of Implementing Problem-Based Learning (PBL) in Mathematics: A Review of Literature. *International Journal of Academic Research in Business and Social Sciences*, 6(12), 490-503.
- Padmavathy, R. D., & Mareesh, K. (2013). Effectiveness of Problem Based Learning In Mathematics. *International Multidisciplinary e-Journal*, 2(1), 45-51.
- Rusmono. (2012). *Strategi Pembelajaran dengan Problem Based Learning itu Perlu*. Bogor: Ghalia Indonesia.
- Slavein, R. E. (1989). Cooperative learning and student achievement. *The Education Digest*, 54(6), 15.
- Suherman, et al. (2001). *Strategi Pembelajaran Kontemporer*. Bandung: JICA-Universitas Pendidikan Indonesia (UPI).
- Zakaria, E., Chin, L. C., & Daud, M. Y. (2010). The effects of cooperative learning on students' mathematics achievement and attitude towards mathematics. *Journal of social sciences*, 6(2), 272-275.